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**GPS DEVICE FOR MEASURING WAVE
HEIGHT AND CURRENT DIRECTION AND
SPEED AND GPS SYSTEM FOR
MEASURING WAVE HEIGHT AND
CURRENT DIRECTION AND SPEED**

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a GPS device for measuring the wave height and current direction and speed, which can be used as an observation device such as an oceanological observation device by measuring the height of the waves and the frequency spectrum thereof, and to a GPS system for measuring the wave height and current direction and speed using such a device.

2. Description of the Related Art

Marine research, which is essential for the survival of people, has been conducted with the object of collecting fundamental data for designing vessels, predicting weather changes by measuring tidal currents, and preventing disasters at sea. Devices for measuring the wave height and current direction and speed have been suggested as oceanological observation devices suitable for such marine research. Devices of four types for measuring the wave height, that is, ultrasonic, hydraulic, step-type, and accelerometric devices, have already found practical use. In the ultrasonic and hydraulic devices for measuring the wave height, the wave height is measured by a method of measuring the distance to the sea surface by emission of ultrasonic waves from an observation device immersed to the sea bottom, or measuring the height of the sea surface by detecting the water pressure. In step-type devices for measuring the wave height, the wave height is measured by detecting the height of the sea surface with a row of electrodes arranged in the height direction on the shore or the like. In the accelerometric devices for measuring the wave height, the wave height is measured by detecting the acceleration of the vertical movement of a floating body with an accelerometer disposed on the floating body and twice integrating the detected acceleration.

However, a variety of problems were encountered when the devices for measuring the wave height of those four types were used for accurate measurement of wave height in a random point on the sea or ocean. Thus, with the ultrasonic and hydraulic devices for measuring the wave height, limitation is placed on the measurable distance from the sea bottom to the sea surface. Therefore, the wave height could be measured only in the sea with a depth of several dozen meters and the usability range of the devices was limited. The step-type devices for wave height measurement required the installation of an electrode row on the shore and the like. Therefore, the device could be used only in harbors or bays. By contrast, the accelerometric devices for measuring the wave height have an unlimited utilization range because the floating body can float in any point. However, the problem inherent to devices of this type was that the detected vertical acceleration data contained errors and those errors were accumulated by two-time integration, thereby degrading the accuracy of wave height measurements. Further, the common problem of the devices of those four types was that the cost of the entire device was high because it used expensive measurement sensors.

In the field of devices for measuring the current direction and speed, electromagnetic measurement devices have been implemented. Such devices measure the tidal current as

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changes in the electric field, but because they are installed in an immersed state on the sea bottom, the current direction and speed in the vicinity of sea surface cannot be measured. Furthermore, because measurements are conducted in a single point, the tidal current in a wide range cannot be measured. One more problem is that the entire device is very expensive because costly sensors are employed.

Japanese Patent Application Laid-open No. 10-185564 has disclosed a method for measuring the wave height. With this method for measuring the wave height, a fixed station for receiving electromagnetic waves emitted by a GPS artificial satellite is installed in a known position on the shore, at least one receiver for receiving electromagnetic waves emitted by a GPS artificial satellite and output electromagnetic waves of the fixed station is installed on a buoy floating on the sea surface and anchored to the sea bottom, a relative position of the receiver with respect to the fixed station is measured by a static positioning method, changes in the relative position are measured by a kinematic positioning method, and the wave height is computed based on the changes in the relative position. However, with the kinematic positioning method, a GPS station serving as a reference point disposed on the ground is required and the base line length to the measurement point is limited to no more than 10 km. Therefore, from the standpoint of practical use and cost, the problem is that the system is difficult to construct and use.

As described hereinabove, a variety of drawbacks are inherent to the devices for measuring the wave height and current direction and speed that have already found practical use. Accordingly, the problem that should be solved is in measuring directly the wave height and the flow of fluid in the vicinity of the water surface, which changes the position of a floating body, at any point on the sea, a lake or a marsh by conducting accurate measurements of the three-dimensional position of the floating body that flows on the sea, lake, or marsh.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the above-described drawbacks and to provide at a low cost a device for measuring the wave height and current direction and speed, which is capable of accurately measuring the wave height and current direction and speed in any position on the sea or ocean and also a system for measuring the wave height and current direction and speed which uses such a device.

More specifically, it is an object of the present invention to construct at a low cost a device and system for measuring the wave height and current direction and speed that can measure the wave height and current direction and speed with a high accuracy in any point on the sea and ocean or fresh water and can be employed for a long time, by using low-cost measurement sensors and without complicating the device for measuring the wave height and current direction and speed.

In order to attain this object, the GPS device for measuring the wave height and current direction and speed comprises a floating body capable of floating on a fluid such as seawater, fresh water, and the like, a GPS (global positioning system) antenna for receiving GPS signals, a GPS receiver for processing the GPS signals received by the GPS antenna and measuring the three-dimensional position, and a data recording unit for recording the position data relating to the three-dimensional position measured by the GPS receiver, wherein the GPS antenna, the GPS receiver, and the data recording unit are installed on the floating body.